The multi-objective optimal design of semi-active controllers for vehicle suspensions with Magnetorheological damper

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Abstract

The controller design of semi-active vehicle suspensions usually has multiple design requirements that need to be satisfied. In this paper, an efficient set-based multi-objective optimization method is suggested for the controller optimal design problems of vehicle suspensions with Magnetorheological (MR) damper. By using the set preference information, the decision maker's preferred part of the Pareto optimal frontier can be found directly. The suggested method is performed in the framework of the micro genetic algorithm. By treating the multi-objective optimization as a single-objective optimization on sets, the micro genetic algorithm is modified to solve the problem. Each individual in the population is a solution set, and its fitness is assigned according to the set preference information. To demonstrate its efficiency, three test functions are used for pairwise comparisons between the suggested method and three typical algorithms. Eventually, it has been used to the multi-objective optimal designs of three representative semi-active controllers for vehicle suspensions with MR damper including the skyhook controller, the hybrid controller and the Takagi-Sugeno fuzzy controller, where the design parameters of the controller are chosen as the design variables and three performance objectives considered are ride comfort, road holding and suspension deflection, as measured by the mean square error of the sprung mass acceleration, suspension deflection, and tyre deflection, respectively. The numerical results demonstrate that the presented method is able to solve the semi-active controller multi-objective optimal design problems efficiently.

Keywords: Multi-objective optimal design, Semi-active controller, vehicle suspension, Magnetorheological damper, Genetic algorithm